

## **APPENDIX F**

### **Condensate Collection and Treatment System**

#### **Emission Calculations**

## **1.0 Introduction**

The emissions calculations were performed consistent with the July 1, 1994 EPA PCP exclusion guidance. The EPA PCP guidance states actual emissions prior to the modification should be compared to emissions after the change assuming no change in the utilization rate of the source (Section III.B.2.(b), page 15).

As stated earlier, the project will not result in increased production from the kraft mill sources. Actual emissions are calculated using the 1999 production rate for the kraft mill, the current control equipment configuration of the kraft mill, and emission factors developed from Bowater stack tests, EPA, and the National Council for Air and Stream Improvement (NCASI). Future emissions are calculated based on 1999 kraft mill production (per EPA PCP guidance), the proposed control equipment configuration of the kraft mill, and emission factors developed from Bowater stack tests, EPA, and NCASI.

## **2.1 Condensate Collection and Treatment System**

The condensate collection and treatment system has several components that will experience changes in emissions as a result of the proposed condensate steam stripper. The emissions changes for each component are addressed separately in each section below.

### **2.1.2 Biological Treatment Unit Methanol (HAPs and VOCs) Emissions**

Air emissions from biological treatment units, as well as HAP removal efficiencies, were calculated using EPA Appendix C equations. The NCASI spreadsheet containing these equations was used to estimate emissions. The spreadsheet is capable of simulating up to four zones within each treatment unit. The calculations require the following information for each biological treatment unit:

- 1) Temperature of each zone
- 2) Inlet loading to basin
- 3) Outlet loading from basin

- 4) Methanol loading in each zone
- 5) Flow rate in each zone
- 6) Dimensions of each zone (length, width, and depth)
- 7) Number of aerators in each zone
- 8) Total aerator horsepower
- 9) Aerator rotation
- 10) Aerator agitation area
- 11) Aerator impeller diameter

Current Biological Treatment Unit Emissions:

The estimates of existing emissions from each basin are based on measured methanol inlet and outlet loading. The intermediate loading for each zone within the unit was estimated using process knowledge and engineering judgement. A summary of the existing system loading and air emissions is contained in Table 1. The detailed NCASI spreadsheet emission estimates are contained in Appendix K.

**Table 1. Existing Biological Treatment Unit Methanol Air Emissions.**

Unit	Stream	Flow MGD	Inlet mg/l	Outlet mg/l	Fraction			Air Emissions		
					Bio	Air	Eff	g/s	lb/hr	TPY
Primary Clarifier	mill sewer	34	140*	140*	0	0.6	99.4*	1.34	10.6	46
Equalization Basin	mill sewer	34	140	90	28.6	7.1	64.3	14.81	117.5	515
Aerated Stabilization Basin	mill sewer	34	90	0	89.8	10.2	0	13.61	108	473

\* - assumed no biodegradation in clarifier, effluent = 100 - air fraction.

Future Biological Treatment Unit Emissions:

The future emissions estimates are based on measured methanol loading in each condensate stream that will be collected. The overall condensate flow rate and methanol loading are calculated in Table 2. The calculation of total methanol loading was accomplished by prorating the loading from each piece of equipment by the percentage of the total condensate flow. The condensate collection system is estimated to have an average methanol loading of 2,103 mg/l and a flow rate of 800 gallons per minute.

The future methanol loading and flow rate of the mill sewer has been determined by subtracting the flow and loading in the condensate collection system. Because most of the condensate to be collected is currently in the mill sewer, this loading had to be subtracted from the current mill sewer. To accomplish this, the condensate collection system methanol loading was re-calculated assuming a 34 million gallon per day (MGD) flow rate to determine the current methanol loading to the mill sewer (Table 2).

The current condensate loading (71 mg/l) was subtracted from the existing measured mill sewer loading (140 mg/l) to yield the future mill sewer loading (69 mg/l). Table 3 contains a summary of the loading by stream into the wastewater treatment system, and the estimated air emissions. The detailed NCASI spreadsheet emission estimates are contained in Appendix K.

**Table 2. Condensate Methanol Loading.**

Sample Point	Condensate Loading		Condensate Flow		Composite Loading	
					Future 800 gpm mg/l	Current 23,600 gpm mg/l
	lb/hr	mg/l	lb/hr	gal/min		
digesters	629	2,516	250,000	500	1,571	53
decanter underflow	80	7,619	10,500	21	200	7
gas cooler	25	10,000	2,500	5	62	2
storage tank underflow	0	0	4,500	9	0	0
#3 evap. foul condensate	108	3,600	30,000	60	270	9
<b>TOTAL</b>	<b>842</b>	<b>23,735</b>	<b>297,500</b>	<b>595</b>	<b>2,103</b>	<b>71</b>

**Table 3. Future Biological Treatment Unit Methanol Air Emissions.**

Unit	Stream	Flow MGD	Inlet mg/l	Outlet mg/l	Fraction			Air Emissions		
					Bio	Air	Eff	g/s	lb/hr	TPY
Primary Clarifier	mill sewer	32.8	69*	69*	0	0.7	99.3*	0.66	5.2	23
Equalization Basin	mill sewer	32.8	69*	44**	29.1	7.2	63.8	7.11	56.4	247
Aerated Stabilization Basin	mill sewer	32.8	44**	0	89.0	11.0	0	6.94	55.1	241

\* - assumed no biodegradation in clarifier, effluent = 100 – air fraction.

\*\* - ratio based on measurements of existing system.

### 2.1.3 Brown Stock Washer Methanol (HAPs and VOCs) Emissions

The brownstock washers use various sources of mill condensates for shower water. The proposed changes to the condensate collection and treatment system will change the brownstock washer emissions. Some portion of the methanol contained in the condensate shower water is stripped to the air when washing the pulp. NCASI Technical Bulletin 678 contains methods for estimating HAP emissions based on methanol concentration of the brownstock washer shower water. The following formula (TB 678, page 145) was used to estimate methanol emissions:

$$Y = 0.0011X + 0.375$$

where: X = change in shower water methanol content (mg/l)

Y = brownstock washer system methanol emissions (lb/ODTP)

Since a certain amount of methanol is carried into the brownstock washer with the pulp, and we are interested in the emission change rather than the total emissions, the last term of the equation (y-intercept of 0.375) can be neglected to yield the following equation.

$$\Delta = 0.0011X$$

where: X = shower water condensate methanol concentration in mg/l

$\Delta$  = change in emissions from changing methanol shower water concentration

The stripper condensates (following treatment to remove at least 92% of the HAPs) will be used as make-up water on the brownstock washers. The resulting HAPs (methanol) emissions from the make-up stream from the stripper are calculated below:

Total condensate HAP (methanol) loading = 2,103 mg/L

Stripper removal efficiency = 92 percent (63.446(e)(3))

$$2,103 \text{ mg/L} \times (1 - 0.92) = 168 \text{ mg/L}$$

$$\Delta = 0.0011 \times 168 = 0.185 \text{ lb/ODTP}$$

The emission increase can then be calculated using the 1999 kraft mill production of 542,206 ADTP/yr. The resulting emission increase is:

$$0.185 \text{ lb/ODTP} \times 0.9 \text{ ODTP/1.0 ADTP} \times 542,206 \text{ ADTP/yr} \times 1 \text{ ton/2,000 lb} = 45 \text{ tons/yr}$$

Using this equation yields an increase of 45 tons per year when the cleaned condensates are used as make-up shower water.

#### **2.1.4 Condensate Collection Tank Methanol (HAPs and VOCs) Emissions**

The emissions from the condensate collection tank were estimated using the EPA TANKS program. The TANKS program estimates working and breathing losses from tanks using the equations from AP-42. The TANKS program was executed using the physical dimensions of the condensate collection tank.

The Tanks program is capable of estimating emissions from a variety of volatile substances, including organic liquids. The program can also estimate emissions from organic mixtures, however the mixture is assumed to contain only organic compounds by the TANKS program. The program does not contain information to include water in the mixture, which constitutes approximately 99.8 percent of the condensate in this case. Table 2 shows that the methanol concentration in the condensate is 2,103 mg/l, or 0.2 percent. The remaining 99.8 percent is water.

In order to use the tanks program to estimate emissions, the annual throughput and turnovers were calculated assuming only the methanol component of the condensate was in the tank. This was accomplished by determining the total condensate throughput, and multiplying this value by the methanol concentration.

Condensate throughput = 800 gallons/min

Methanol Concentration = 2,103 mg/l

$2,103 \text{ mg/l} \times 3.785 \text{ l/gal} \times 800 \text{ gal/min} \times 60 \text{ min/1 hour} \times 1 \text{ lb}/453,600 \text{ mg} = 842 \text{ lb/hr}$   
 $842 \text{ lb/hr} \times 8,760 \text{ hr/yr} \div 6.59 \text{ lb/gallon} = 1,120,000 \text{ gallons/yr}$   
 $1,120,000 \text{ gallons/year} \div 180,000 \text{ gallons} = 6.2 \text{ turnovers/year}$   
(note: the tank actually will experience 6.4 turnovers per day considering the flow rate of water)

Emissions were then estimated for this volume of pure methanol, and the TANKS model output is contained in Appendix L. This approach is expected to produce overestimate of methanol emissions, since methanol is very soluble in water and vaporization is likely to be somewhat lower than the theoretical values, since some portion of the methanol will remain in the condensate.

The methanol emissions were then estimated based on the tank being vented to the low volume high concentration (LVHC) gas collection system. The LVHC gases are burned in the facility combination boilers. Assuming a conservative estimate of 98 percent destruction of methanol in the facility combination boilers, the emissions from the condensate tank are approximately 0.4 tons per year.

TANKS predicted methanol emissions = 37,567 lb/year  
 $37,567 \text{ lb/year} \times (1-.98) \times 1 \text{ ton}/2,000 \text{ lb} = 0.4 \text{ tons Methanol/year}$

### **2.1.5 Condensate Steam Stripper Methanol (HAPs and VOCs) Emissions**

The steam stripper is designed to comply with 63.446(e)(3), which requires 92 percent removal of HAPs from the condensates collected. The HAPs contained in the stripper off-gases (SOG) will be incinerated in the facility combination boilers, as required by 63.446(f). The emissions resulting from the stripper are estimated as follows:

Methanol loading in condensate = 2,103 mg/l  
Condensate loading to stripper = 800 gallons/min  
Stripper removal efficiency = 92 percent  
Combination boiler destruction efficiency = 98 percent

Methanol feed rate to stripper:

$$2,103 \text{ mg/l} \times 3.785 \text{ l/gal} \times 800 \text{ gal/min} \times 60 \text{ min/1 hour} \times 1 \text{ lb/453,600 mg} = 842 \text{ lb/hr}$$

Methanol in SOG:

$$842 \text{ lb/hr} \times 0.92 = 775 \text{ lb/hr HAPs}$$

Methanol emissions:

$$775 \text{ lb/hr} \times (1 - 0.98) = 15.5 \text{ lb/hr HAPs}$$

$$15.5 \text{ lb/hr} \times 8,760 \text{ hr/yr} \times 1 \text{ ton/2,000 lb} = 68 \text{ tons/yr HAPs.}$$

## **2.1.6 Condensate Steam Stripper Sulfur Dioxide Emissions from TRS combustion**

$$1999 \text{ Kraft mill production} = 542,206 \text{ ADTP/year}$$

$$\text{Hydrogen sulfide (H}_2\text{S) emission factor from NCASI TB 701 (Table 6)} = 0.20 \text{ lb/ADTP}$$

$$\text{Methyl mercaptan ((CH}_3\text{)HS) emission factor from NCASI TB 701 (Table 6)} = 0.90 \text{ lb/ADTP}$$

$$\text{Dimethyl sulfide ((CH}_3\text{)}_2\text{S) emission factor from NCASI TB 701 (Table 6)} = 0.53 \text{ lb/ADTP}$$

$$\text{Dimethyl disulfide ((CH}_3\text{)}_2\text{S}_2\text{) emission factor from NCASI TB 701 (Table 6)} = 0.00 \text{ lb/ADTP}$$

$$\text{Combination boiler TRS to SO}_2 \text{ conversion efficiency} = 100 \text{ percent}$$

Conversion of Hydrogen Sulfide:

$$0.20 \text{ lb H}_2\text{S/ADTP} \times 542,206 \text{ ADTP/yr} \times 1 \text{ yr/8,760 hr} = 12 \text{ lb H}_2\text{S/hr}$$

$$12 \text{ lb H}_2\text{S/hr} \times 64 \text{ lb SO}_2/34 \text{ lb H}_2\text{S} = 23 \text{ lb SO}_2/\text{hr}$$

Conversion of Methyl Mercaptan:

$$0.90 \text{ lb (CH}_3\text{)HS/ADTP} \times 542,206 \text{ ADTP/yr} \times 1 \text{ yr/8,760 hr} = 56 \text{ lb (CH}_3\text{)HS/hr}$$

$$56 \text{ lb (CH}_3\text{)HS} \times 64 \text{ lb SO}_2/48 \text{ lb (CH}_3\text{)HS} = 75 \text{ lb SO}_2/\text{hr}$$

Conversion of Dimethyl Sulfide:

$$0.53 \text{ lb (CH}_3\text{)}_2\text{S/ADTP} \times 542,206 \text{ ADTP/yr} \times 1 \text{ yr/8,760 hr} = 33 \text{ lb (CH}_3\text{)}_2\text{S/hr}$$

$$33 \text{ lb (CH}_3\text{)}_2\text{S} \times 64 \text{ lb SO}_2/62 \text{ lb (CH}_3\text{)}_2\text{S} = 34 \text{ lb SO}_2/\text{hr}$$



Conversion of Dimethyl Disulfide:

$$0 \text{ lb } (\text{CH}_3)_2\text{S}_2/\text{ADTP} \times 542,206 \text{ ADTP/year} \times 1 \text{ year}/8,760 \text{ hours} = 0 \text{ lb } (\text{CH}_3)_2\text{S}_2/\text{hr}$$

$$0 \text{ lb } (\text{CH}_3)_2\text{S}_2 \times (2 \times 64) \text{ lb SO}_2/94 \text{ lb } (\text{CH}_3)_2\text{S}_2 = 0 \text{ lb SO}_2/\text{hr}$$

Sulfur Dioxide Emissions:

$$23 + 75 + 34 + 0 = 132 \text{ lb SO}_2/\text{hr}$$

$$132 \text{ lb/hr} \times 8,760 \text{ hr/yr} \times 1 \text{ ton}/2,000 \text{ lb} = 578 \text{ tons}$$

### 3.0 Condensate Collection and Treatment System Emissions Summary

Emission Unit	PM	SO <sub>2</sub>	NO <sub>x</sub>	CO	VOC
<b>EXISTING EMISSIONS</b>					
Primary Clarifier	0	0	0	0	-46
Equalization Basin	0	0	0	0	-515
Aerated Stabilization Basin	0	0	0	0	-473
<i>Total Existing</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>-1,034</i>
<b>FUTURE EMISSIONS</b>					
Primary Clarifier	0	0	0	0	23
Equalization Basin	0	0	0	0	247
Aerated Stabilization Basin	0	0	0	0	241
Brownstock Washers	0	0	0	0	45
Condensate Collection Tank	0	0	0	0	0.4
Condensate Steam Stripper	0	578	0	0	68
<i>Total Future</i>	<i>0</i>	<i>578</i>	<i>0</i>	<i>0</i>	<i>624.4</i>